Department of Atmospheric and Oceanic Sciences University of Colorado

Fall 2009: Issue 1

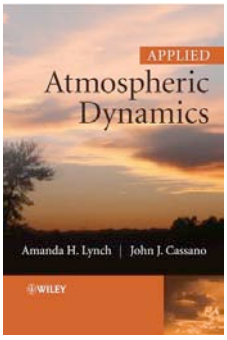
Inside:

Notes from the Chair - Brian Toon

The Department of Atmospheric and Oceanic Sciences (ATOC) at the University of Colorado, Boulder celebrated its third birthday in the fall of 2008. While Atmospheric and Oceanic Sciences have had a presence on campus for decades, it was only in 2008 that PhD and MS degrees in Atmospheric and Oceanic Sciences were created. Nevertheless ATOC is one of the larger graduate atmospheric and oceanic sciences departments in the U.S. with 67 current PhD seeking graduate students. In 2006 and 2007 the Chronicle of Higher Education reported a ranking of U.S research universities in numerous academic fields based on the productivity of the campus. CU was rated in the top 10 in the U.S. in Atmospheric Sciences and in Physical Oceanography in both years.

ATOC has been fortunate to recruit some of the brightest young scientists as faculty in the past few years. Of our 11 tenure track faculty, 4 are Assistant Professors, and 4 Associate Professors. Our newest hires are Baylor Fox-Kemper, an oceanographer, Katja Friedrich, a radar meteorologist, Cora Randall, a satellite remote sensing and middle atmosphere expert, and Peter Pilewskie, a satellite and aircraft radiation balance expert. We are also fortunate to have 2 research faculty. Most recently Roger Pielke Sr. joined us. Roger is well known for his many textbooks and his work on regional scale meteorology.

ATOC continues to be prolific in publications, and awards. John Cassano (and ex-ATOC faculty member Amanda Lynch, now in Australia), published a new text book *Applied Atmospheric Dynamics*. Linnea Avallone was awarded a CU Provost's Faculty Achievement Award in 2007 for developing an instrument to measure ice water content. Cora Randall was awarded a CU Provost's Faculty Achievement Award in 2008 for her work to understand the role of high energy particles from the sun in changing stratospheric ozone. Brian Toon was recognized by the United Nation's Environmental Program for contributing to the 2007 Nobel Peace Prize won by the IPCC and Al Gore. Doubtless many of our colleagues across the U.S. and the world were recognized in this way for their decades of hard work to alert the world to changes in climate and global ozone. ATOC affiliate faculty member Margaret Tolbert has been awarded the American Chemical Society National Award for Creative Advances in Environmental Science and Technology. ATOC affiliate faculty member Jose-Luis Jimenez has been given the Kenneth T. Whitby Award from the American Association for Aerosol Research.



ATOC has also been busy with construction. A new lab was built for Professor Peter Pilewskie's group. In addition, the University provided funds for us to construct a three story atmospheric observatory in the Duane Physics building. The first floor contains teaching space, which is being used in a sequence of new laboratory classes, the second floor has an outside area for instruments, and the top floor has a dome for optical instruments including a lidar.

Check us out on the web: http://atoc.colorado.edu/index.php

ATOC Rooftop Teaching Laboratory and Observatory

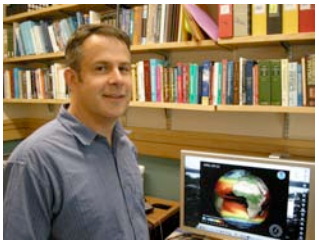
In the fall of 2005 ATOC was awarded $100,000 from the Dean's Fund for Renovation to modify existing space on the third and fourth floor in the Duane Physics Building D-wing for a laboratory-classroom facility. Construction of this unique rooftop observatory and teaching lab was completed in December 2006. The third-floor classroom accommodates 18 students with ample bench-top space for working with instrumentation and performing experiments and lab tests. Student computers are equipped with high performance multifunction data acquisition hardware and software. High quality software applications such as Labview and IDL give students access to the tools necessary to design computer interfaces to instrumentation and sensors and to analyze the acquired data. Hands-on learning is facilitated by a variety of instruments and environmental sensors for student use such as digital manometers, anemometers, thermistors, benchtop power supplies, and oscilloscopes. NSF recently funded the acquisition of a number of new instruments for the lab.

A fourth-floor lab/observatory is located directly above the teaching lab and is accessible via a 4'x4' lift from which instruments can be hoisted to either location. The enclosed 4th floor facility houses instrument control electronics and data acquisition systems, and in situ gas and particle samplers with inlets mounted through the south-facing wall. There is a rooftop platform supported on four piers in front of that wall and pavers to allow easy access to rooftop-mounted instrumentation.

The rooftop facility is an ideal location where faculty and students can install instrumentation and students can learn about sensor development, measurement principles, instrument calibration, and data acquisition and analysis. Because several members of the faculty in ATOC routinely deploy instruments on a variety of airborne and ground-based platforms in field experiments, this facility is used as a training ground for a variety of measurements related to the chemical composition of the atmosphere, its radiative properties, precipitation, and remote sensing.

Above the 4th floor penthouse is an adjoining observatory dome housing a Light Detection and Ranging (LIDAR) system to measure aerosol layers high in the atmosphere. This instrument was designed and built by eight University of Colorado graduate and undergraduate students in Aerospace Engineering.

Welcome new faculty! **Baylor Fox-Kemper**



Our new oceanographer, Baylor Fox-Kemper, arrived at the Unversity of Colorado in August, 2007. Baylor does process modeling and theory, and likes developing and improving physically-based parameterizations of unresolved processes. Two parameterizations that he has worked on--one for submesoscale eddy restratification (Fox-Kemper et al. 2008) and one for mixing by Langmuir circulations--are already implemented in prototype versions of IPCC fifth assessment models. Another parameterization for mesoscale eddy momentum fluxes--an extension of the Leith nonlinear viscosity scheme--is being used in the prototype ECCO2 high-resolution data assimilating ocean models (Fox-Kemper &

Menemenlis, 2008; http://ecco2.org).

Before coming to CU, Baylor worked as a research scientist with Raffaele Ferrari at MIT on the Climate Process Team on Eddy-Mixed Layer Interactions (CPT-EMILIE). This work drew him away from Princeton and GFDL (NOAA's Geophysical Fluid Dynamics Lab), where he had been modeling the interaction of surface processes and mesoscale eddy fluxes already with Geoff Vallis and Bob Hallberg. His interests in mesoscale eddies extend back to his MIT/WHOI thesis work with Joe Pedlosky. The CPT-EMILIE work blossomed when a simulation designed to examine the interaction of mesoscale eddies (20-200km) with even smaller scales (2-10km) revealed a sea of submesoscale instabilities--mixed layer eddies--that can strongly restratify the near-surface ocean by tipping over surface density fronts. Unlike mesoscale eddies, these eddies extend only through the mixed layer of the ocean and exhibit fast time (1 day) and small spatial scales (100m-10km). Some of these eddies have been seen as spiraling pattens of surfactants in photos taken by astronauts. A simpler set of simulations focusing on the slumping of a single ocean density front by submesoscale eddies allowed for detailed study of the process (Boccaletti et al,, 2007) and eventually resulted in a parameterization (Fox-Kemper et al., 2008) now included in the IPCC 5th assessment versions of both the GFDL and NCAR models. Baylor is still working with NCAR scientists on understanding the impacts of submesoscale eddy processes.

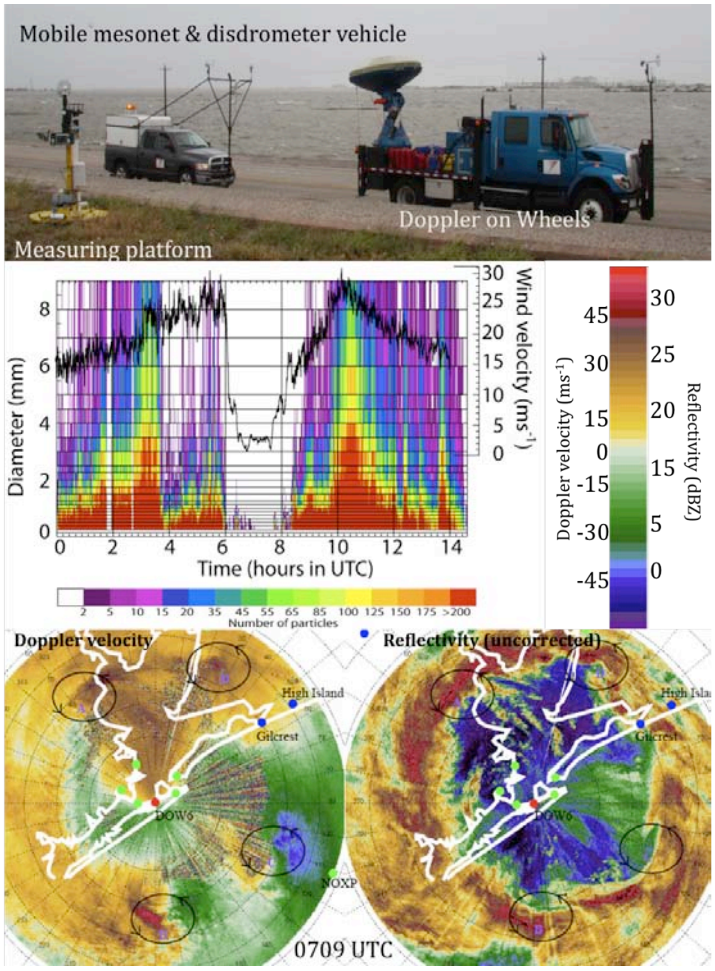
Since arriving at CU, Baylor has broadened his scope to work with new colleagues in Boulder. A trial parameterization of Langmuir mixing, inspired by discussions with Keith Julien (CU-Applied Math) and Greg Chini (UNH-Engineering) during a visit to CU by Chini, is already showing promise in preliminary tests in collaboration with NCAR's Bill Large, Peter Sullivan, and Synte Peacock. Apparently, neglecting Langmuir circulations was a serious oversight and helps to explain persistent ocean model biases in entrainment of chlorofluorocarbons (CFCs) and too shallow summertime mixed layers. A CU applied math graduate student (Adrean Webb) has been helping to analyze satellite and wave-model data. Inspired by a combination of an enthusiastic ATOC graduate student (Samantha Stevenson), new model fidelity in simulating El Nino (NCAR's Markus Jochum), and a compelling narrative of the unknown processes affecting Pliocene climate by Peter Molnar (CU-Geology), Baylor has begun to think about the factors that may affect the strength and variability of ENSO that may have changed during the Holocene and Pliocene eras. Finally, Baylor's long-held interest in accurately parameterizing mesoscale eddies continues in two synergistic directions. First, an NSF-funded collaboration with NCAR's John Dennis and Frank Bryan will diagnose tracer transport in a new way in a global mesoscale-eddy-resolving simulation just completed at IBM's Watson Research Center. Second, he has been discussing with Keith Julien and ATOC's Jeff Weiss how multiscale mathematical approaches and simulations can inform parameterizations of mesoscale eddies.

Welcome new faculty! **Katja Friedrich**

In January 2008, I joined ATOC as an assistant professor. My research focus is related to investigating kinematic and microphysical processes relevant for cloud formation and enhancement of precipitation by analyzing data from in-situ and remote sensing instruments such as airborne and ground-based radars, lidars, and satellites. Over the last years, I have studied processes along cold fronts, orographic features and processes within severe weather systems accompanied by heavy precipitation like thunderstorms, tornadoes, hurricanes, and winter storms to improve quantitative precipitation estimation and understanding of basic mechanisms to improve numerical weather forecast techniques. In 2008 my students and I intercepted hurricane Ike deploying instruments at the landfall point in Galveston, TX. By using a Doppler radar and in-situ measurements, we studied wind and precipitation structures in the hurricane rain bands and within the eye to better understand driving kinematic and microphysical mechanisms for hurricane

intensification.

Before moving to Boulder, I have lived in Locarno, Switzerland and worked as a researcher for the Swiss weather service. I investigated the optimal usage of radar polarimetry in mountainous environment. I received my master degree from the Meteorological Institute at the University of Leipzig, Germany – famous for its chair Vilhelm Bjerkness founder of polar front theory and modern numerical weather forecasting. For my Ph.D. I joined the German Aerospace Center, Oberpfaffenhofen close to Munich, to develop a new radar technology – bistatic radar – with which three-dimensional wind vector fields can be derived. In 2002 I received a Ph.D. in Physics from the Ludwig-Maximillians University in Munich, Germany. The first time I fell in love with Colorado was during a post-doctorate at CIRES/CU and NOAA in 2003-2004. I focused on investigating processes relevant for convection initiation along thunderstorm outflows and cold fronts in the Southern Great Plains.



Upper panel: During hurricane Ike in September 2008, 10 measuring platforms (green dots in lower panel), 2 mobile mesonet and disdrometer vehicles (green dots) and the Doppler on Wheels, DOW6, X-band radar (red dot lower panel) were deployed at Galveston Island. Middle panel: Measurements of drop size distributions and wind velocity clearly indicated the passage of the hurricane with several intensive rain bands, maximum winds in the eye wall and no precipitation with low winds in the eye (6-830 UTC). Lower panel: Doppler velocity and reflectivity at 0.5deg elevation during the passage of the eye measured by the DOW. Several mesocyclones (black line circles) were observed at the edges of the eye. Range rings were plotted every 2.5 km starting at a distance of 5 km from DOW6.

Welcome new faculty! **Roger A. Pielke Sr.**

Roger A. Pielke Sr. is Senior Research Associate [ATOC] and Senior Research Scientist [CIRES] at the University Of Colorado – Boulder. He was a Professor in the Department of Atmospheric Science at Colorado State University before joining ATOC and CIRES in 2005.

Roger was elected a Fellow of the AMS in 1982 and a Fellow of the American Geophysical Union in 2004. From 1993-1996, he served as Editor-in-Chief of the US National Science Report to the IUGG (1991-1994) for the American Geophysical Union. He has served as Chief Editor of the Monthly Weather Review and, with Bill Cotton, the Journal of Atmospheric Science. In 1998, he received NOAA's ERL Outstanding Scientific Paper Award (with Conrad Ziegler and Tsengdar Lee) for a modeling study of the convective dryline. He was designated a Pennsylvania State Centennial Fellow in 1996, and named the Pennsylvania State College of Earth and Mineral Sciences Alumni of the year for 1999 (with Bill Cotton). He

currently is one of four members listed by ISI HighlyCited in Geosciences at the University of Colorado at Boulder (and one of two in ATOC).

He authored Mesoscale Meteorological Modeling (1984; 2nd Ed 2002), Hurricane (1990), Human Impacts on Weather and Climate, co-authored with Bill Cotton (1995; 2nd Ed 2006), Hurricanes: Their Nature and Impacts on Society, co-authored with Roger Pielke Jr. (1997), and was Co-Chief Editor (with R.A. Pielke, Jr.) of a book entitled Storms (1999).

Roger has published over 330 papers in peer-reviewed journals, 50 chapters in books, co-edited 9 books, and made over 700 presentations during his career to date. He also launched a science weblog in 2005 to discuss weather and climate issues. This weblog was named one of the 50 most popular Science blogs by Nature Magazine on July 5, 2006 and is located at http://climatesci.org. A detailed summary of his research along with electronic copies of papers can be obtained from http://cires.colorado.edu/science/groups/pielke/pubs/.

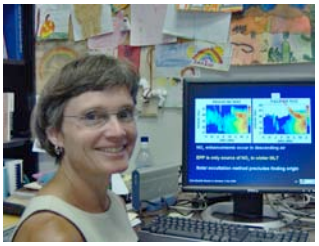
Roger's current research focuses on the role of landscape and aerosol process as they affect regional and global climate, the development of more computationally efficient and accurate parameterizations for use in atmospheric models, and in the analysis of climate and weather metrics including surface and tropospheric temperatures, humidity and winds, and ocean heat content.

Welcome new faculty! **Peter Pilewskie**

Peter Pilewskie joined the University of Colorado in fall 2004 with a joint appointment in ATOC and in the Laboratory for Atmospheric and Space Physics (LASP). He teaches courses in radiative transfer, remote sensing, and environmental instrumentation. Peter is a co-Investigator for the NASA Solar Radiation and Climate Experiment (SORCE), the current NASA mission measuring the total and spectral solar irradiance from space, and he is Principal Investigator for the Total and Spectral Solar Irradiance Sensor (TSIS), the future mission to insure the continuity of those same climate data records. His research interests include: solar spectral variability and its effects on terrestrial climate; quantifying the Earth-atmosphere radiative energy budget; airborne radiometry to study the effects of clouds and aerosols on climate; surface, airborne, and satellite remote sensing of clouds and aerosols; and theoretical atmospheric radiative transfer.

Prior to his arrival at CU, Peter spent 15 years at the NASA Ames Research Center where his research centered on airborne measurements of atmospheric radiation, cloud and aerosol remote sensing, and analysis of the atmospheric radiative energy budget. He has flown instruments on NASA, NOAA, NSF, DOE, and NRL aircraft, including Unmanned Aerial Vehicles (UAVs). Along with the space-based measurements of the Sun, he continues to participate in airborne missions. Peter's group recently participated in the International Polar Year NASA ARCTAS (Arctic Research of the Composition of the Troposphere from Aircraft and Satellites), and NOAA ARCPAC (Aerosol, Radiation, and Cloud Processes affecting Arctic Climate) and ICEALOT (International Chemistry Experiment in the Arctic LOwer Troposphere) experiments.

Welcome new faculty! **Cora Randall**



Cora Randall joined the ATOC faculty as an associate professor in January of 2006. Her main area of expertise is remote sensing of the earth's middle atmosphere, with particular emphasis on the polar regions. Dr. Randall is a current or prior member of numerous satellite science teams, including missions run by NASA and DOD as well as the Canadian and

Japanese space agencies. She teaches courses in introductory weather, chemistry and climate, and remote sensing for ATOC.

Professor Randall earned a PhD in physical chemistry in 1985 from the University of California, Santa Cruz. After several years of post-doctoral work that focused on time-resolved laser spectroscopy using polarized light, she became a research scientist at CU's Laboratory for Atmospheric and Space Physics in 1989, with which she is still affiliated. During her career at LASP Dr. Randall analyzed data from numerous space-based instruments, including the Hubble Space Telescope Goddard High Resolution Spectrograph, a number of satellite-based solar occultation instruments, and the High Resolution Dynamics Limb Sounder instrument onboard the NASA Aura satellite. Her work currently focuses on validation of remote sensing measurements and global models, investigations of polar stratospheric ozone loss and related processes, the effects of energetic particle precipitation on the mesosphere, stratosphere, and possibly troposphere, and polar mesospheric clouds.

Dr. Randall leads a group of more than 10 students and junior scientists involved in satellite data analysis and global modeling of the earth's atmosphere. In 2008 she was awarded the University of Colorado Provost's Faculty Achievement Award because her work "brings students into [her] research and involves an international group of colleagues. [Her] work on energetic particles and atmospheric chemistry has clearly been important in a resurgence of interest in changes occurring in Earth's upper atmosphere". In 2008 Professor Randalll was also awarded a NASA Group Achievement Award for her involvement in the NASA Aeronomy of Ice in the Mesosphere (AIM) mission to study polar mesospheric clouds. She is currently the PI of an instrument on AIM. Her primary focus at the current time is simulating the atmospheric effects of energetic particles in the Whole Atmosphere Community Climate Model (WACCM), a global, coupled chemistry model developed at the National Center for Atmospheric Research, and evaluating the performance of this model as relevant to polar processes in the stratosphere and mesosphere.

Faculty notes: **Linnea Avallone**

Linnea Avallone's research group focuses on the development of instrumentation for measuring trace gases in the atmosphere. They are currently working in two research areas – airborne studies of ice clouds and ground-based studies of boundary layer chemistry in the polar regions. The former involves participation in organized field campaigns in which the ice water content of high-altitude clouds is probed. This work will lead to a better understanding of the importance of cirrus clouds in the Earth's radiation balance and will help to improve retrieval of cloud properties from satellite-based remote sensing instruments. Dr. Avallone's group also participates in studies of polar boundary layer ozone depletion, making measurements of ozone and related trace gases at sites in the Arctic and Antarctic. This work has led to the establishment of better connections between the halogen source gases (derived from sea-salt aerosols) and observed ozone depletion events.

Faculty notes: **John Cassano**

I joined ATOC as an assistant professor in January of 2004. Since joining ATOC I've taught our Weather and Atmosphere (ATOC 1050), Introduction to Atmospheric Dynamics (ATOC 4720), Desert Meteorology (ATOC 4750), Introduction to Atmospheric Physics and Dynamics (ATOC 5050), and the weather forecasting seminar (ATOC 6020). I've also co-authored a textbook, *Applied Atmospheric Dynamics*, which is intended for use in undergraduate atmospheric dynamics courses.

My research deals with the weather and climate of polar regions. My group works on developing regional atmospheric models and applying these models for weather prediction, studies of atmospheric processes, and for climate related studies. For one of my recently funded projects I am collaborating with scientists at the Naval Postgraduate School, University of Washington, Iowa State University, and University of Alaska – Fairbanks to develop a high-resolution Arctic system model. This model will have horizontal resolution that is an order of magnitude finer than current generation global climate system models. The Arctic system model will incorporate atmosphere, ocean, sea ice, and land hydrology models, and will allow us to study the coupled processes acting in the climate system. One goal of this project is to understand why global climate models have failed to reproduce the observed rapid decline in Arctic sea ice cover. Another recently funded project involves the use of an unmanned aerial vehicle, known as Aerosonde, to make late winter measurements over a persistent polynya (a region of open water surrounded by sea ice) at Terra Nova Bay, Antarctica. The field phase of this project will take place during September 2009, and will be one of the first NSF funded projects to utilize UAVs in the Antarctic. This project will also make the first 3-dimensional mesoscale observations of the winter Antarctic atmosphere. The Terra Nova Bay polynya is of interest as this area is a source of Antarctic bottom water formation, which contributes to the global thermohaline circulation.

Faculty notes: **Weiqing Han**

Weiqing's primary research interest is the circulation and dynamics of oceans, especially the Indian Ocean, on a wide range of spatial and temporal scales, as well as air-sea interaction, climate variability and change. Her approach is to combine data analysis, numerical modeling and theoretical methods to address the targeted science issues.

Currently, her group is conducting a few research projects: variability of the tropical Indian Ocean induced by intraseasonal atmospheric forcing, interannual-to-decadal variability of the Indian Ocean thermocline depth and upper ocean heat content, vertical warming structure and decadal change of the Indian Ocean in the past few decades, and characterization and modeling of the Philippines Strait dynamics using the ROMS 4DVAR data assimilation system. These projects are funded by NSF, NASA Ocean Vector Wind Science Team, NASA Ocean Surface Topography Science Team and ONR.

To assemble the latest research on the Indian Ocean and its climatic impact, Weiqing organized an Indian Ocean session at the American Geophysical Union 2008 Fall Meeting, with Prof. Julian McCreary (U. Hawaii) and Prof. Ragu Murtugudde (U. Maryland). In addition, in collaboration with scientists at the National Center for Atmospheric Research (NCAR), Weiqing has also been participating in understanding the role of the global thermohaline circulation in global climate change.

Faculty notes: **Darin Toohey**

Darin works on his instrument on the NASA WB-57f

My research involves development and deployment of instruments for in situ measurements of trace gases and aerosols in the atmosphere to better understand the mechanisms that determine distributions of species important in climate change. I am currently carrying out measurements from the NCAR C-130 of submicron particles that are the nuclei of droplets in clouds to better understand cloud-formation processes and ocean-land interactions that are important for the climate of the southern hemisphere. I am also involved in a new study to assess the impact on stratosphere ozone of proposed schemes to mitigate climate change by releasing small particles in the upper atmosphere or by launching mirrors into space.

Faculty notes: **Brian Toon**

Brian plans a mission in TC4 with Dave Starr of Goddard

Brian's group is active in both planetary and earth atmospheres.

Brian was the project scientist for NASA's Tropical Chemistry, Clouds and Climate Coupling experiment, TC4, in 2007. This experiment used three high altitude NASA aircraft to better understand the tropical upper troposphere and lower stratosphere. In total more than 600 scientists from across the nation were involved. Brian's group is also working with several satellites including Aura, the Aeronomy of Ice in the Mesosphere mission and CALIPSO. As part of this work the group is constructing cloud and aerosol physic packages within the NCAR global climate models. These models allow the size distributions of particles to be studied for the first time. Students in the group are modeling noctilucent clouds, micrometeorites, subvisible cirrus clouds, upper tropospheric sulfates, dust storms, and sea salt. The group is also developing a suite of new models of the atmospheres of Titan, Mars and the Archaen Earth based on the NCAR climate models. The group is also exploring geo-engineering schemes for Earth. Brian is continuing studies of the effects of nuclear conflicts on the Earth, and presented the Charney lecture at the Spring 2008 AGU meeting on this topic.

Faculty notes: **Jeff Weiss**

Jeff Weiss works on theoretical and computational aspects of the atmosphere, ocean, and climate system. Coherent structures such as vortices, jets, fronts, and convective plumes are ubiquitous in the climate system. Weiss investigates these structures in systems from idealized fluid turbulence to realistic models and observations with a focus on their formation, dynamics, transport, and their influence on biological and chemical processes. Weiss also studies theoretical aspects of the predictability of weather and climate, applying concepts from nonlinear dynamics, chaos, and statistical physics to better understand the limits of predictability and to improve forecasts of weather and climate.

Faculty notes: **Joan Alexander**

Adjoint Professor Joan Alexander joined the department in 1999. Her research focuses on atmospheric waves and their many effects at both local and global scales. "My work involves both observational analyses and theoretical modeling to better understand the nature of these waves and their sources. We are using observations from satellite, balloon-borne radiosondes, aircraft, and radar. Our theoretical models focus on the dynamics and thermodynamics of storms, on wave propagation, and on wave forcing of the global circulation. My students, postdocs and I are interested in both the cause and effect relationships between atmospheric waves and changes in weather and climate." Joan's research also has applications to ice cloud formation. Gravity waves and equatorial waves influence cirrus cloud formation in the tropics that affects stratospheric humidity, and polar stratospheric clouds that affect ozone. "We study such cloud effects through our collaborations with other scientists at CU, NCAR, and around the world. Good collaborations are key both to a productive research program and to enjoying this work!"

Professor Alexander and student Stephanie Evan discussing an analysis of equatorial inertia-gravity waves.

Faculty notes: **Tom Warner**

Dr. Warner received a PhD in Meteorology from The Pennsylvania State University in 1976, and was on the faculty of the Department of Meteorology at Penn State for over twenty years, teaching courses in atmospheric dynamics, small-scale weather processes, numerical weather prediction, and climate change. His research included the development of computer-simulation models that were used for both operational weather prediction and for investigation of physical processes. During the 1980's, he led a Penn State research group that developed the first operational computer-based forecast model that was capable of representing small-scale weather processes. That effort has led to the proliferation of dozens of similar modeling systems worldwide that are used for public weather forecasting.

Since assuming a joint appointment at the University of Colorado and the National Center for Atmospheric Research about fifteen years ago, he has been the lead scientist for a number of projects that have involved the development of a better understanding of mesoscale processes and improved atmospheric modeling techniques. Current projects include development of improved ensemble-prediction and data-assimilation methods, current- and future-climate downscaling, land-atmosphere interaction, atmospheric processes in the littoral-zone, the coupling of mesoscale models with LES models, studies of urban meteorology, the use of atmospheric models for mitigating the effects of infectious diseases, and forecasting for wind-energy applications. He teaches courses in atmospheric dynamics, numerical weather prediction, desert meteorology and climate, and general meteorology.

Graduate student news

Awards: Many of our current graduate students have been fortunate to receive awards to support their research;

Charles Bardeen was awarded a National Center for Atmospheric Research Advanced Study Program Postdoctoral Fellowship for 2008. He is now an ASP postdoc at NCAR.

Kelly Baustian was awarded a CIRES graduate research Fellowship for 2008.

Susanne Benze won an Outstanding Student Paper award at the AGU Joint Assembly held in

Ft. Lauderdale, FL, May 27-30, 2008 for her paper, "Comparison of CIPS and SBUV/2 Using a Generalized SBUV-Type Approach", a paper on the AIM PMC measurements.
Peter DeCarlo was awarded an NSF International Research Fellowship for 2008.
Sam Dorsi was awarded a NSF graduate Fellowship for 2008.
Adrienne Dove was awarded a NASA Graduate Student Researchers Program Fellowships for 2008.
Christa Hasenkopf was awarded a NSF graduate Fellowship for 2007.
Sherri Heck was awarded a Carol B. Lynch Graduate Fellowship for Fall of 2008.
Laura Holt was awarded an honorable mention in the 2008 National Science Foundation Graduate Research Fellowship Program competition for her proposal, "The effects of energetic particle precipitation on stratospheric ozone and climate".
Rachael Humphrey was awarded the University of Colorado at Boulder, United Government of Graduate Students (UGGS) TA Effectiveness/Teaching Excellence Award for 2007.
Ryan Neely was awarded a NOAA Graduate Student Fellowship for 2008. He was also awarded the Raytheon Fellowship from the AMS.
Amber Ortega was awarded the University of Colorado Chancellor's Fellowship for 2008.
Samantha Stevenson was awarded a CIRES graduate research Fellowship for 2008.
Richard Urata was awarded a NASA Graduate Student Researchers Program Fellowships for 2008.

Graduate student news-**Carl Drews**

Carl Drews is researching wind-driven storm surge, using the Regional Ocean Modeling System (ROMS) and the Weather Research and Forecasting Model (WRF). The height of storm surge depends on the length of the continental shelf and inversely upon the depth of that shelf. The two study cases are the Nile delta region and Manila Bay in the Philippines. WRF simulations of historic hurricanes will be used to force the ROMS model and evaluate the danger to population centers.

Graduate student news-**Sherri Heck**

Since pre-industrial times, human activities, such as the burning of fossil fuels and land-use changes, have added a significant amount of CO_2 to the atmosphere. As a result, global atmospheric CO_2 concentrations have increased from the pre-industrial average of ~ 280 ppm to the present day value of ~ 380 ppm. In order to help predict future changes in climate, it is important to identify the processes (e.g. El Nino, drought, increased precipitation, forest fires, insect outbreaks, etc.) that may be affecting CO_2 fluxes. Currently there exist fairly established methods of estimating CO_2 fluxes on the local, continental and global scales, albeit with considerable uncertainties. However, their respective CO_2 flux footprints are either too large (~ 1,000 - 10,000 km, continental scale) or too small (1 km, local scale) to appropriately estimate their relationships to driving human and natural mechanisms. Regional scale (~ 100 – 1,000 km) flux estimates are being implemented to help fill this key gap. In terms of CO_2 concentration measurements, due to monetary constraints and the complexity of the terrain, the Rocky Mountain West has largely been neglected. However, novel regional flux estimation methods and a new low-cost, continuous, CO_2 analyzer have since been

developed to help address this spatial gap. I am investigating regional CO_2 diurnal cycles and fluxes in the US Rocky Mountains and Southwest (and have plans for Africa) and how these compare to various models (the Transcom study and NOAA's CarbonTracker model). In addition, I am investigating processes (such as forest fires) that may be affecting the spatial and temporal pattern of CO_2 sources and sinks.

In many instances, the areas where few carbon measurements have been made correspond to areas that are populated by those underrepresented in the science, technology, engineering and math (STEM) professions. To address this disparity, my project includes a component focused on collaborating with people from groups currently underrepresented in STEM by partnering with Diné College on the Navajo Reservation and the University of Nairobi and the Kenya Meteorological Department in Kenya, Africa.

Graduate student news-**Keah Schuenemann**

Using the self-organizing map (SOM) algorithm, model and reanalysis data are analyzed over a North Atlantic domain in order to make predictions of Greenland precipitation. Upon comparing 15 IPCC AR4 models to the ERA-40 reanalysis, a 3-model ensemble was created that best represents the synoptic climatology of the North Atlantic as well as Greenland precipitation from 1961 to 1999. Simulations from the 3-model ensemble SRES A1B scenario are utilized, with the SOM, to analyze changes in the synoptic climatology, and attribute precipitation changes through the 21st century. Results show a northward shift in storm track under the warmer climate scenario, causing less precipitation to be produced dynamically over the southeast coast of Greenland, but precipitation over the remainder of the ice sheet to increase, with largest increases over the southwest and upper-east coasts of Greenland. Thermodynamically, however, precipitation increases by large magnitudes over the entire Greenland ice sheet due to higher evaporation rates in a warmer atmosphere and, therefore, more precipitable water available. The thermodynamic increase in precipitation is amplified next to areas where open water replaces sea ice, allowing for an increase in moisture availability in the future, and resulting in larger precipitation amounts on the nearby ice sheet. The combination of these two effects cause the annual Greenland precipitation at the end of the 21st century to be 28% larger than current rates, and up to 60% larger in northern and eastern Greenland regions. Unfortunately, this increase in precipitation may not be large enough to counteract Greenland ice sheet ablation from melt and ice sheet dynamics in the future.

ATOC Alumni: Where are they now? **David Bailey**

After graduating from the ATOC program at CU, I went on to do a postdoc at the University of Washington working with Peter Rhines in Oceanography. My work with Peter concentrated on deep convection in the Nordic and Labrador Seas and how these interact with the North Atlantic meridional overturning circulation. I was in Seattle for three years, and then did a second postdoc with Paul Schopf at the Center for Ocean-Land-Atmosphere studies (COLA) in Maryland. I worked with Paul on his hybrid-coordinate ocean model, Poseidon, looking at numerical issues with the model and deep dense oceanic overflows. Most recently I took on a position back in Boulder at the National Center for Atmospheric Research. In my position as CCSM Polar Climate Working Group (PCWG) and sea ice model liaison, I am responsible for supporting the scientific projects of interest to the PCWG, generating sea ice diagnostic plots for simulations for the general CCSM community, aiding new users of CCSM with experimental setup and design, and ongoing maintenance and development of the Community Ice CodE (CICE), the sea ice component of the CCSM. Some recent examples of PCWG projects that I've been involved in are: providing sea ice concentration from IPCC 21st century

projections for use in polar bear habitat prediction models; performing ensemble experiments using the CCSM to investigate possible sea ice response under idealized greenhouse gas commitment scenarios and predictability of September sea ice extent. I have also been involved with 20th century hindcast runs using the CCSM as a basis for short-term prediction studies. I am currently testing and developing new parameterizations in the sea ice for melt ponds, shortwave radiation, and aerosol deposition on sea ice. I am also peripherally involved in the grand challenge project to run the CCSM at very high resolution.

ATOC Alumni: Where are they now? **Florence Bocquet**

I graduated in August 2007. My field of research was in atmospheric chemistry.

I held a 2-year post-doc research associate position at the Cooperative Institute for Research in Environmental Sciences (CIRES) on CU campus (October 2007-2009). Now I am the Managing Director for the Center for Research and Education in Wind (CREW) at CU.

I study stable (nocturnal) boundary layer dynamical processes, such as turbulence. The data I am looking at were collected during the 30-day CASES-99 campaign that occurred during the month of October 1999. I analyze dissipation rate of turbulent kinetic energy (epsilon) data collected by flying a kite (called the Tethered Lifting System, or TLS). I am also studying tower turbulence data, such as the vertical velocity variance.

My work also consists of comparing mesoscale model outputs to observed data. One part of this work was for the GABLS3 project and we used the MIUU mesoscale model. This work was accomplished at the Meteorological Institute of Stockholm University (April-June 2008). We plan on further testing the MIUU model outputs by comparing runs to the TLS data obtained during CASES-99.

ATOC Alumni: Where are they now? **Gannet Hallar**

Gannet Hallar is now director of Storm Peak Laboratory (SPL) where she is involved in a multitude of research projects involving aerosols and mercury measurements. Specifically, she is studying long-range transport events from Asia to the U.S. SPL is operated by the Desert Research Institute and located near Steamboat Springs, Colorado, at an elevation of 10,530 ft. (http://stormpeak.dri.edu/ for more information).

SPL provides an ideal location for long-term research on interactions of atmospheric aerosol and gas-phase chemistry with cloud and natural radiation environments. SPL includes an office-type laboratory room, a cold room for precipitation and ice sample handling, a large roof deck for outside sampling equipment, a full kitchen, and two bunk rooms with sleeping space for nine. Besides her research interest, Gannet is extensively involved in outreach activities at SPL. Currently she is the principal investigator of a NSF Award titled “Geoscience Research at Storm Peak with Diversity” providing an atmospheric field research opportunity for undergraduate students of Minority Institutions. She also directs a community program at SPL, giving field trips to all 5th grade students in public elementary schools within North-Western Colorado. This program provides a three day lesson on the topics of weather and climate and reaches over 250 elementary students each year. She is now the PI for an NSF ADVANCE award titled ASCENT (Atmospheric Science Collaborations and Enriching NeTworks) to provide leadership workshops for early career women in atmospheric science. You can reach Gannet at: ghallar@dri.edu

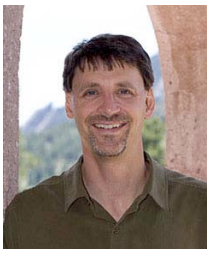
ATOC Alumni: Where are they now? **Thomas Kampe**

Attaining my Ph.D. through ATOC allowed me a mid-career change in emphasis from engineering to science. After 15+ years involved in the development of satellite remote sensing instrumentation both at Santa Barbara Research Center (MODIS) and Ball Aerospace & Technologies Corp. (CALIPSO, Quickbird), I recently accepted a Staff Scientist position with the National Ecological Observatory Network (NEON), an NSF-funded corporation located here in Boulder, CO. I am also a Research Affiliate with the Institute of Arctic and Alpine Research (INSTAAR), University of Colorado at Boulder. NEON (neoninc.org) is a continental-scale research platform for discovering and understanding the impacts of climate change, land-use change, and invasive species on ecology over a 30-year period. The goal for NEON is to enable the first continental-scale comparisons of research transects focused on some of the nation's most pressing ecological challenges including continental-scale climate change, the effects of urban and ex-urban development, agriculture and biofuels, nitrogen deposition, invasive species and infectious diseases, and climate change effects through the water cycle.

At NEON, I am developing the airborne observatory platform and its suite of instruments that will compliment ground-based measurements and map the spatial heterogeneity of ecosystem structural and functional changes occurring over large geographical regions. As part of this effort, we will integrate data at multiple scales (field data, airborne hyperspectral and LiDAR remote sensing data, and satellite data) to assess the response of ecosystems to land use and climate change at regional to continental scales. Particular areas of interest for my research include atmospheric correction of hyperspectral data to account for aerosol contamination and improving our understanding of the radiative and societal impact due to increasing dust emissions in the Southwestern desert regions resulting from increasing anthropogenic impacts in the desert regions.

My wife Terri and I make our home in Boulder where our youngest daughter attends elementary school. Our eldest daughter recently graduated from Colorado State University and our middle daughter is currently a CSU undergraduate in the Warner College of Natural Resources.

ATOC Alumni: Where are they now? **David Lawrence**



David Lawrence: After completing my PhD, I spent three years at the University of Reading in the UK. There, I began working on land-atmosphere interactions, studying how vegetation and soil moisture control surface turbulent fluxes and, in turn, atmospheric processes such as precipitation.

I have spent the last five years at NCAR working in the Climate Change Research and Terrestrial Sciences Sections. Much of my research has been centered on Arctic climate change and its affect on the terrestrial system. My overall research aim is to determine whether or not changes in the Arctic terrestrial system that alter the surface energy, water, or carbon fluxes will be a positive or negative feedback onto climate change. To this end, I have worked, together with another CU alum Andrew Slater now at NSIDC, to improve the representation of permafrost in the Community Land Model (CLM, the land-surface scheme used in the NCAR-hosted Community Climate System Model; CCSM). We are utilizing the model to assess how much permafrost could thaw under projected climate change and what factors (warming, snow, vegetation, sea ice retreat) control the degree of permafrost thaw. I am also contributing to the development of CLM hydrology, snow, and biogeochemical cycling as well as helping incorporate an ice sheet model into CCSM.

ATOC Alumni: Where are they now? **John Ortega**

I left CU in February 2006 to start a post-doc position at Pacific NW National Laboratories in Richland Washington. Within a couple of weeks of starting there, I went to Mexico to take part in the NSF/NCAR sponsored MILAGRO campaign (Megacity Initiative: Local and Global Research Observations) to study the processing of gasses and aerosols as they are advected from the city center towards the north. I operated a PTR-MS (proton transfer reaction mass spectrometer) during this campaign from the G-1 aircraft (operated by the US DOE) and continued in that role for the next 1.5 years. I also was responsible for VOC measurements using the PTR-MS in TEXAQS2 (Texas Air Quality Study #2) and a field campaign where we measured gasses and aerosols directly from the exhaust of F15 fighter planes on Tyndall Air Force Base in Florida. Also during this time, I completed two other projects. First, I designed and constructed a GC/MS/FID to give the laboratory the ability to measure VOCs from air collected in cans from various campaigns. This was very similar to instrumentation I built as a graduate student in ATOC when I worked at INSTAAR. The 2nd project was designing and building an upgraded PTR-MS interface between the drift tube (where chemical ionization occurs) and the mass analyzer. This involved designing and building a new vacuum system with differential pumping to obtain a much higher gas throughput than had previously been obtained. Then, utilizing ion optics, a much greater ratio of ions:neutrals could be obtained, thus increasing the concentration of analyte ions (by 10-100x) available for analysis.

In the spring of 2008, I started a new position as a research associate in CU's Mechanical Engineering Department, working with Mike Hannigan, Jana Milford, and Shelly Miller. The primary objective of this work is to characterize the health effects associated with the concentrations and chemical composition of coarse particulate matter (PM) in Greeley and Denver. Coarse PM is the size range of particles between 2.5 and 10 um (aerodynamic diameter).

I have long been passionate about renewable energy, partly because one of the greatest contributors to the increasing atmospheric CO2 burden, is the burning of fossil fuels for electricity generation. So I started searching for ways to utilize my skills in the growing field of renewables. Last spring (2008), I applied for a fellowship to work on bio-fuels from C2B2 (Colorado Center for Bio-refining and Bio-fuels). I was honored (but quite frankly, shocked) to be selected as one of the first year fellows. So in November (2008), I moved to the Colorado School of Mines (and also performing some experiments at the National Renewable Energy Laboratory) in Golden. I will be using molecular beam mass spectrometry (MBMS) to characterize gasses and aerosols that are formed during the pyrolysis of biofuels.

ATOC Alumni: Where are they now? **Charlie Zender**

The ATOC department grew out of the APAS (Astrophysics, Planetary, and Atmospherics Sciences) department. Only one atmospheric science graduate students joined APAS in 1991: me. I had to take the same astronomy-dominated core curriculum as my fellow APAS students. Fortunately we shared a common language: radiative transfer.

I bolted CU to work on tropical cirrus modeling at NCAR. When I graduated in 1996, PAOS was just blasting off. Today ATOC has dozens of kindred graduate students who actually take classes in their chosen field of research! I spent three more years in Boulder, at NCAR, then, in 1999, moved to UC Irvine to profess Earth System Science (ESS). Both ATOC and the UCI ESS departments seem to be small, young, and conducive to the interdisciplinary collaborations that I thrive on. Since CU, I have studied atmospheric absorption, dimers, dust, fires,

snow, soot, supercomputing, wind speed variability, and valley fever. For more details, see http://www.ess.uci.edu/~zender.

ATOC Alumni: Where are they now? **Alicia Frazier**

For those of you who don't know or remember me, when I started in the ATOC program in the Fall of 2004 my son was five months old and my daughter was seven, and I had just uprooted them from New Mexico. They are now five and almost twelve. Since receiving my M.S. in 2006, we have remained in Louisville. My family very much enjoys the area and did not want to move again, big surprise. It took me about about three months to find a job, and when I finally did it was as an inspector at a wastewater plant. It seems I couldn't get on at NOAA or NCAR or the like, as they only wanted people with PhDs. The wastewater gig lasted for as long as it took me to get hired on with the State of Colorado - seven long months. I began working for the State managing the daily operations of the fuel-testing laboratory. I tested various samples of fuel from around the State to ensure that they met the proper Federal specifications, and began various enforcement actions if they did not. While this was a great job to have, as I was the only person in the lab on a daily basis, I didn't exactly like huffing gas fumes all day long. A little over a year into that job, a position came open in the Department of Public Health and Environment which was right up my alley.

I started my current position as a Physical Science Researcher/Scientist II with the Technical Services Program in the Air Pollution Control Division of CDPHE in August of 2008. I specialize in ozone and air toxics research. Presently, I am in the process of setting up three new ozone and air toxics monitoring sites in the Front Range area. Once they are in place, my focus will shift to designing and implementing a statewide ozone research study to be carried out this summer. I am not tied to a desk in an office somewhere, and get to spend a great deal of time out in the field in this beautiful state. So let's see, fieldwork, job security, great benefits and a pretty nice paycheck...I don't think I could ask for much more than that!

I consider myself very lucky to have a job that allows me to use the knowledge I gained while earning the graduate degree I worked so hard for, especially given the current state of the economy. I hope all the great friends I made while at CU are doing well and enjoying life as much as I am right now. Keep up all that hard work and it will pay off for you!

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